

Underground Storage Tank System Field-Based Research Project Report Response to Comment Table

Peer Reviewer	Report Section	Page Number	Paragraph Number	Sentence Number	Comment/ Recommendation	Comment Response
Dr. McCarty	Introduction	2	1	3	It appears the primary goal stated is not consistent with Senate Bill 989 which states the research is “to quantify the probability and <u>environmental significance</u> of releases from petroleum underground storage tank systems <u>that meet certain upgrade requirements</u> .” Single walled, double-walled, and hybrid tank systems were to be included, but the emphasis was not on a comparison between them as suggested by the report objectives. A statistically valid sample program is to be used.	The stated objectives of the report have been restated to make clear their consistency with Senate Bill 989.
Dr. McCarty				9	Report states 180 UST facilities are to be targeted, but only a fraction of this number is covered in this report.	This statement has been removed.
Dr. McCarty	Site Selection	2	1	12	Senate Bill 989 calls for study of petroleum storage tanks, but this is essentially limited to gasoline tanks.	Although only gasoline tanks were randomly selected, other types of petroleum tanks (diesel, racing fuel) were included when they were at the same facility as the randomly selected tank. The vast majority of regulated petroleum USTs contain gasoline or diesel motor fuels, so any bias in this direction that might have occurred has little potential impact on the results.
Dr. McCarty			2	1	Says results from 55 facilities are reported, but the data in Appendix 1 lists data from only 36 facilities.	The reviewer apparently counted the facilities incorrectly since 55 were included. The revised table in the appendix includes lines to separate the UST systems at each facility to aid in identifying the number of facilities.

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Dr. McCarty		3	2	1	Indicates 15% of systems tested were hybrid and 10% were single-walled. Appendix 1, however, lists no hybrid systems and lists 39 single-walled systems, which is greater than 10%.	The reviewer may have misunderstood the definition of hybrid systems since the appendix included the reported number of each type of system.
Dr. McCarty	Testing Procedure	3	1		Indicates Tracer Research Corporation with their “Tracer Tight” method was used for the testing. This procedures that were used to evaluate and select this procedure over other possible procedures are not indicated. No reference is provided that would demonstrate the validity of this method, and its advantages and limitations. Since this is a proprietary method and the tracer chemicals used are not revealed, we have nothing for judgement except the companies claims. More must be provided than this to be able to evaluate the procedure used in the testing. Procedures used for introducing the tracer without contamination needs to be provided. Number of probes used, their construction are important to know. Limitations, such as use in clay and groundwater levels need to be specified. No indication is provided as to the different sites and their depths is not provided.	A discussion of the internal process at UC Davis and the SWRCB for selecting the Tracer method was added. In addition, references to third party evaluations were added, and summaries of the evaluations are provided in Appendix 1. Substantial additional detail about the procedures involved in the testing including tracer addition, probe construction and installation, numbers of probes, and limitations on the method have all been added. Maps are provided showing probe locations at all tested facilities.

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Dr. McCarty	Results – Initial Test.	4	1	2	A comparison is made between all tanks, rather than between facilities. Some facilities had several tanks, and some had only one. Many of the tanks were connected together at a facility. Comparing all tanks together in this manner does not provide the statistical sampling that is called for. While it is useful to evaluate all tanks at a given facility to see the extent of cross-connections and to add to the data base, the summary approach here is not valid statistically. For example, of the 42 facilities with either 3 or 4 tanks, 19 of them had all tanks either with non-detect or all with detect. Thus, only about One-half were mixed detect/non-detect. This would not occur if the tanks were randomly distributed. Obviously, some facilities had leaking tanks, in general, and some had tanks without leaks. Some other method of grouping must be used to arrive at the statistically valid conclusions called for in legislation.	This is a good point. It is not clear that analyzing the results on a system by system basis is wrong, but it is clear that there correlations exist between tracer results at the several tanks present at most facilities. A facility-level view of the data has been added to the report (Table 3) as well as discussion about the limitations of the system-level analysis. Reasons for the non-random system results are also discussed.
Dr. McCarty	Table 1	4			Maximum tracer concentration column values are listed wrong. For example, the second row contains values >ND and <0.5 ug/L, but the column says only <0.5 ug/L. With this heading, the results should include all values below 0.5 ug/L, including NDs.	The requested change was made.
Dr. McCarty	Sources of Tracer Releases	4	1	4	Indicates the “Enhanced TracerTight method is certified. By whom? Where is the reference?	References to two independent evaluations of the TracerTight method were added to the report, and summaries of these evaluations are now provided as Appendix 1.

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Dr. McCarty				8	Indicates data from three reference sites are given in the Appendix. Why only 3? Such information should be given for all the sites. Not only sampling well horizontal location should be given, but depth as well to allow judgement as to validity of sampling. No indication of soil type is provided so one might judge whether the sampling location is a good one.	Maps are provided for tracer concentration distributions at all sites and TVHC concentrations are included for most sites. The depth of probes follows general rules which are now discussed in the text. Soil type was clean pea gravel in all cases but two and this is now stated in the text. This highly permeable material makes probe location far less critical than it would be in native material.
Dr. McCarty		5	1	17	Indicates only one case where a leak of liquid phase was detected. The leak was evidenced by a high TVHC level (>100 mg/L), but by quite a low (0.16 ug/L) tracer level. Since the majority of detectable tracer concentrations were well above this value, several in the 10s of ug/L, then it appears the tracer testing method is not very successful at finding liquid leaks. The TVHC analysis appears to be the primary method for doing this. However, TVHC values are not recorded anywhere, except for the crude summary in Figure 1, page 8.	The reviewer fails to notice several points of importance. First, the liquid leak that was discovered is estimated to have been SMALLER on a mass basis than the largest vapor releases identified and therefore the correspondingly lower tracer concentration is expected. Because Tracer Research Corporation used their most volatile tracers in this study it is true that the method can detect a smaller vapor leak (on a mass basis) than liquid leak, but this by no means indicates that the method is a poor one for liquid releases. TVHC concentration maps are now included for most of the sites.
Dr. McCarty		6	1	3	Indicates in most cases the highest tracer concentrations were observed near the fill/vent riser(s) and suggests looking at tracer distributions for Site SY43 in the Appendix, but the figure does not show this in any recognizable way.	Explanation of how to read the maps in Appendix 2 has been added.

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Dr. McCarty			2	1	Says spill bucket tests were performed and some passes and some did not. What is the spill bucket test, and what does it show? This test is not described and no reference is provided for it.	The method for the spill bucket test has been added and its significance is now discussed, although there is no “standard method” to reference.
Dr. McCarty			3		Says results generally point to vapor containing portions of UST systems. I expect this is true, but data to support this conclusion are not provided. This is an important issue and needs to be better documented by showing relationship between sampling locations and test results.	The addition of all tracer distribution maps in Appendix 2 addresses this problem.

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Dr. McCarty	Release Magnitude	7	1	1	Says tracer detections were judged to have occurred as vapor phase releases in all but one case. This important conclusion is not supported by the information presented. The arguments provided here are not convincing. For example, on line 11 it indicates that the TVHC/tracer ratio in the tank head space is 3 mg/ug while the liquid ratio is 750 mg/ug. It further suggests this fact can be used to distinguish whether a release is associated with vapor or liquid. However, only vapor is sampled outside of the tank, not liquid. If liquid at a ratio of 750 mg/ug leaks from the tank, then the vapor that rises from that leak will still only have a ratio of 3 mg/ug, just as in the tank. Thus the high TVHC/tracer ratios sometimes found outside the tank are not related to this. They probably are related to leakage of TVHC from the tank that occurred before the tracer test, and mixing of vapor from past releases with some of the tracer releasing. Figure 1, page 8, shows many ratios higher than 3 mg/ug to illustrate this point. The conclusion that might be reached is that measurement of TVHC concentration itself may be a better indication of major leaks than the tracer test. In any event, it would be well to make TVHC measurements before introducing tracer, and after as well, which would indicate newer releases. All values should be reported.	The relevant issue here is mass fluxes rather than equilibrium concentrations. The properties of the tracers cause > 90% of the mass released to be in the vapor phase under almost any conceivable scenario, especially in the high permeability pea gravel around USTs. The same can be said for most of the TVHC components, although with more qualifications. Therefore, the mass ratio of the two compounds within the excavation zone vapor space will be based on the relative rate at which they are released. This depends on the source of the release as described in the text. Problems with the TVHC portion of this ratio have been added to the discussion of these calculations. TVHC maps have been added in Appendix 2.

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Dr. McCarty		8	1	16	It would certainly be helpful to know what the tracers are. The usefulness of proprietary chemicals is difficult to judge. For this reason, one needs to have good references to independent evaluations of them to learn of their physical and biological properties.	References to the independent evaluations (and the EPA methods that guided them) have been added and some indications of their physical/chemical properties have been added in Table 1.
Dr. McCarty	Retest Results	9	1	9-11	Indicates changes following system repairs. What were the “repairs.” Were there repairs to other tanks, but detection still found on retesting? What repair was done to the one that was detect before but not after? Why was it repaired if it had no detect?	Sample repairs are now listed and possible reasons that a system might start to release tracer after a repair are also proposed.
Dr. McCarty				15	Indicates no detects were primarily in systems with low detect concentrations previously. Doesn’t this say something about the randomness of results? Not clear what the last sentence in this paragraph means.	This last sentence has been removed and the section reworded to clarify that some large tracer releases were successfully addressed during the retesting process.
Dr. McCarty	Conclusions	10	2	1	Conclusion is not justified. Only one liquid phase release was positively identified. However, analysis was not sufficiently definitive to conclude that other liquid phase leaks did not occur. Based upon Figure 1, page 8, high TVHC concentrations were found with several tanks. A better protocol or more investigation is required to reach this conclusion.	Additional support and explanation for this statement has been added. The authors of the study continue to believe that the approach for categorizing releases as vapor or liquid is sound and have retained the statement in question.

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Dr. McCarty		11	1	3	States that the environmental significance of the leaks has not been determined. But this is what is called for in Senate Bill 989. The testing has indicated a majority of tanks leak. This may not be a statistical sampling, but it suggests that a more definitive analysis is needed to more exactly determine the sources of leaks, and also the environmental significance of the leaks that are found. Statement says releases are orders of magnitude less than a liquid tracer release with the same tracer concentration. That means that tracer concentration does not tell whether it is a liquid or vapor leak. Conclusion here about only one liquid leak is thus again not justified.	A significant amount of additional discussion about environmental significance has been added and, consequently, the statement about not determining environmental significance has been removed. Discussion of the method's relative ability to detect liquid and vapor releases has been added.
Dr. McCarty	Appendix 1	13-17			Last column gives tank near which highest concentration was measured, but this is not specific enough. Need figures for all facilities and more specific information on sample locations.	Figures for all facilities were added to Appendix 2.
Dr. McCarty	Appendix 2	18			Need similar figures for all facilities, not just three.	Figures for all facilities were added to Appendix 2.

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Dr. McCarty	Addendum	1	1	9	States that each term is good within a factor of 2. It is not clear where this estimate comes from, certainly many of them can be off by much more than that. But even with the factor of two, and five unknowns, the overall error would be quite large. However, there are some factors that make the equation unrealistic. First, it assumes that the detections result only from gaseous leaks, and not from liquid leaks. The equation is not valid for liquid leaks. Second, it is not clear where the value of 1000 in the denominator comes from. The relative partitioning of tracer and liquid between gas and liquid phases is needed, but not indicated anywhere in the equation. Thus, I do not understand how the equation was formulated. The equation also assumes that all vapor entering the trench around the tank stays there and builds up there. It assumes none diffuses to the atmosphere and none diffuses into the soil surrounding the trench, which are pretty poor assumptions for many cases. It also assumes no partitioning of tracer occurs between gas and solid phases. These assumptions are too major for this to be a useful equation for estimating mass flux from the system.	Statement about the factor of two has been eliminated. It is agreed that the equation is only valid for vapor leaks, a modified form of the equation was used to estimate the size of the one confirmed liquid release. The basis for the factor of 1000 is now stated (it is a vapor to liquid volume conversion for gasoline). The properties of tracer chemicals in Table 1 and the common subsurface conditions around USTs mean that little if any tracer is partitioned to liquid or solid phases so these items do not need to be included in the calculations. The assumption that tracer remains in the subsurface is a significant one, but is reasonably justified for many sites that are covered by asphalt or concrete with an excavation zone of high permeability pea gravel surrounded by native material. Although the equation provides only an approximate release rate, it is important to give the reader some information about the significance of the releases and so this calculation has been retained.

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Dr. McCarty	Recommendations				Even though the study is not a statistically valid one, the data indicate that many tanks have some sort of leaks. However, the study is not sufficiently definitive to answer the basic questions asked in Senate Bill 989. That is the probability and environmental significance of releases, the sources and causes of releases, and deficiencies in leak detection systems. With the evidence in hand that may releases do occur, the need is to concentrate on obtaining definitive answers to the sources and cause of releases, their environmental significance, and deficiencies in leak detection systems. Collecting more data of the kind listed here will not lead to answers to the import questions being asked. Thus, a change in direction is recommended that will answer the important question asked in Senate Bill 989.	As discussed above, the study's statistical validity has been enhanced by addition of a facility-level analysis of the data. Future work under this project will indeed be redirected per the reviewer's suggestions toward better characterization of the sources and significance of releases.
Dr. Hazen	Testing Procedure	3	3	1	While I understand the need for protecting a proprietary method it would have helped the reviewer if the tracers were specifically identified in a separate enclosure.	General physical/chemical properties of the tracers are provided in Table 1, which has been added. Specific information about the tracers cannot be provided without a signed confidentiality agreement.
Dr. Hazen	Results	4	1	5	Siegel (1956) is a very outdated reference, though the statistics are valid a newer reference would be more appropriate.	The statistical procedures referenced have not changed, and the authors generally prefer to use the oldest relevant reference to acknowledge the originators of a particular analytical approach.

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Dr. Hazen	Effects of Response Bias on the Results	10	1	7	...results for the portio of... Should be “portion of”	This change was made.
Dr. Hazen	Conclusions	10	2	1	“ a fact that certainly would not have been true before implementation of the regulations” This statement is not supported by any information, data, or reference in the document and should be removed.	The sentence has been eliminated, but the idea is retained (and referenced) elsewhere in the revised document.
Dr. Hazen	Site Selection	3	1	3	Insert comma after “In 13% of cases...”	This change was made.